II. *On the Temperature of the Springs, Wells and Rivers of India and Egypt, and of the Sea and Table-lands within the Tropics. By Captain* Newbold, *Madras Army, F.R.S.*

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PROFESSOR Jameson, in his chapter on the hydrography of India, justly remarks, "Although India, like other great tracts of country, contains many springs, these have hitherto attracted but little attention. The temperature of but few of them is known; their magnitudes and geognostical situations are scarcely ever mentioned; and their chemical composition, excepting in a very few instances, has been neglected. The most important feature in the natural history of *common* or *perennial* springs, namely their temperature, is rarely noticed, although a knowledge of this fact is illustrative, not only of the mean temperature of the climate, but also of the elevations of the land above the level of the sea; and our information in regard to their chemical nature is equally meagre†." Since the publication of these remarks, much has been done by Prinsep and others in these branches of Indian hydrography, but more remains to be effected before this reproach can be wiped out. The heat of springs having a temperature little above the mean of that of the surrounding country has been rarely noticed, though I feel convinced many such exist in India. That of springs of high temperature, more attractive to the casual observer, has been more remarked.

My own observations, and the few inferences I have ventured to draw from some of them, are not offered as sufficient data for the establishment of laws, but merely as a contributory mite to knowledge; in the view of courting inquiry and observation by others more competent and better situated for continued research than myself. The thermometric observations have been snatched generally on the line of march, or during hasty travel: since my return to England, through the kindness of Mr. Roberton, they have been adjusted to the indications given by the standard thermometer of the Royal Society.

The observations extend at irregular intervals from Alexandria to Malacca, or from 31° 13′ of north latitude to within 2° 14′ north from the equator; and between the meridians of 27° and 103° of east longitude. I had continued those on the temperature of the sea as far as the Bosphorus and Black Sea, but have judged them

* This paper having unfortunately been mislaid after its receipt by the late Assistant Secretary, the reading of it was thus necessarily delayed.—S.H.C.

† Ed. Cab. Cyc. No. 8. p. 287.

superfluous in a paper limited almost to the subject of intertropical temperature.

In the columns of the registers, the latitude and longitude, the approximate height above the sea, the nature of the surrounding formation, the depth to the surface of the water and depth of water, the temperature of the air, the month during which each observation was taken, and the approximate annual mean of the climate in which the wells, &c. occur, are specified as far as practicable. In the column of remarks will be found a few observations on the chemical nature of the water, and on the size of the wells and springs*. Those were selected which contained water all the year round; though all were, more or less, subject to fluctuation during the wet and dry seasons. The wells in Egypt differ from the "*bouries*" of India in being less open and exposed to atmospheric influence. Those in the valley of the Nile are mere shafts sunk through the black alluvium to an impervious marly and sandy bed, to depths varying, according to the distance from the river, from ten to forty feet. Their circumferences, like those of the Indian "pot wells," are from nine to twelve yards. They mainly depend on the river for water, which is supplied by infiltration through the soil,—a circumstance to be taken into consideration in all indications afforded of their temperature. The wells in the deserts of Egypt, like those of Ajmír and the western deserts of India, are frequently of great depth, lying under strata of sand, gravel, and a calcareous sandstone, on an argillaceous or marly bed, sometimes at a depth of 300 feet below the surface of the surrounding country. In the granitic districts of Upper Egypt, in the Thebaid desert, however, I have observed springs rising through the almost vertical strata to the surface.

In India, most of the wells marked as occurring in granite, trap, limestone and sandstone, result from springs, and are consequently not so much influenced in temperature by the monsoon rains as those in lateritic rocks, which, from their porous structure, admit of the percolation of rain water to a considerable extent.

The temperature was generally taken at about 10 A.M., a time when I found it to approximate nearest the diurnal mean; and, whenever practicable, at the depth of about ten feet from the surface.

The following are the general results of many hundred observations:—

1st. In low latitudes the temperature of the deepest wells and springs is a little higher than the mean temperature of the air. Exceptions occur: for example, the temperature of a deep well at Gádigánúr, on the banks of the Toombuddra, between the 15th and 16th parallels of north latitude, at an elevation of about 1200 feet from the sea, was so low as 72°·5 (the temperature of the air in the shade, at the time of observation, 80°·5), while that of the springs and river in the vicinity was from 77° to 79°·5. Ranges of hills, attaining an altitude of 1500 feet above the plain, rose at no great distance; a circumstance suggesting the probability that the cold spring had its

* The observations of others will be denoted in the column of remarks by the names of the observers. The scale throughout is that of FAHRENHEIT.

source at an elevation having a mean temperature lower than that of the plain where the water appears on the surface.

2nd. The temperature of strongly saline and sulphureous springs is, on the average, higher than those of pure water.

3rd. Both saline and cold springs are seen to occur within a few feet from thermal and freshwater springs; a fact to be ascribed probably to their rising through different seams of the subjacent strata (often highly inclined), and to the different depths and heights from which the supply of water is derived.

4th. The temperature of wells, particularly those with a small area, much used for purposes of irrigation, is thereby artificially increased.

5th. The temperature of shallow exposed wells, springs and rivers, especially such as have sandy beds, is subject to great diurnal fluctuation, conforming, though to a less extent, to that of the superincumbent atmosphere. The surface water of deep wells partakes of this fluctuation, to a depth varying according to the transparency of the water, extent of surface, degree of exposure, and clearness of the sky. In muddy water the surface is heated to a greater extent, but a foot or two deep is less affected by the calorific action of the solar rays than clear water.

The transparent water of a large well at Bellary, lat. 15° 5′ N. and long. 76° 59′ E., situate on a table-land elevated 1600 feet above the sea's level, and containing sixteen feet of water, I found, at the depth of nine feet from the surface, to vary but one degree during the day, from sunrise to sunset, and this in several hundred experiments. The minimum, 79°·5, took place a little after sunrise, and the maximum, 80°·5, at 3 P.M. following those of the air. The diurnal variation of the water an inch below the surface amounted to 12°. During the commencement of the dry weather, as the heat increased, the water gradually decreased, and the diurnal fluctuations became greater, and increased at a greater rate than that of the decrease of the water.

Thermal Springs.—The thermal springs, both of India, the peninsula of Sinai and Egypt, are, with few exceptions, either mineral or gaseous. Those near the shores of the Red Sea are sulphureous; and strictly speaking, perhaps, should not be classed as thermal springs, from the great probability of their being connected with the volcanic belt that passes under the bed of the Red Sea, and bursting up from its watery fetters appears in the semi-dormant volcano of Gebel Teer, and in the lavas of Aden, beyond the straits of Babel-Mandel. The highest known temperature of the thermal springs is 102°, viz. that of El Kasr in the Oasis of Dakhleh; in the peninsula of Sinai, 91°6, that of the Hummám Músa, hot-baths of Moses (Wells of Elim?) near Tor. It is probable, from reports given me by the Arabs, that the Hummám Pharáon, hot-baths of Pharaoh, about eighty-five miles northerly from Tor, are of higher temperature. The maximum attained by the thermal springs of India is 194° at Jumnotri in North Hindostan (lat. 30° 52′ N.); a temperature almost equivalent, at that elevation—10849 feet above the sea's level—to the boiling point of water, and 18° higher than that of the hottest known thermal spring of Europe unconnected with present active vol-

canos, namely, 176° FAHR., that of Chaudes Aigues in Auvergne. The temperature of the hottest known thermal spring in the world, according to M. ARAGO, is that of Las Trincheras in Venezuela, stated, on the authority of HUMBOLDT and BOUSSINGAULT, to have increased 11° since 1806 to February 1823, viz. from 195° to 206° FAHR. Had M. ARAGO stated its elevation above the sea, a better comparison between its temperature and that of Jumnotri might have been formed. It would be interesting to observe whether any similar increment of heat takes place in the chain of thermal springs that rise abundantly along the great line of dislocation at the southern base of the Himálaya chain, or whether the temperature falls, as in some thermal springs among the East Pyrenees. It is certain that the majority of the springs strictly termed thermal, occur in India at or near lines of great faults occasioned by the upheaving of plutonic rocks, a fact that speaks intelligibly as to the great depth at which the earth's crust has been broken up.

Hot springs were found by BURNES in the salt districts of the Punjaub. In Thibet, M. CSOMA DE KOROS mentions the occurrence of hot springs between U and Ts'ang. They are numerous in the mountains lying east from the Ma-p'-ham lake, especially at one place, where there is a hole out of which vapour continually issues, and at certain intervals, as in Iceland, hot water is ejected with great noise to the height of twelve feet. The water of the hot springs of Assam was found by Mr. J. PRINSEP to contain bitumen and sulphuretted hydrogen. One held in solution a portion of muriate of soda. Many other warm springs are known to occur, besides those mentioned in the register, regarding the temperature and chemical composition of which further information is desirable. For instance, those of Hummám Pharáon on the east shore of the Red Sea; of Vizrabhaee, forty-eight miles north of Bombay; at Mohr on the Bancoot river, about seventy-five miles south of Bombay; of Soonup Deo, and Oonup Deo among the Satpoora hills in Khandésh; of Rishï-kúnda in Rajmahal; of Muktinath and Bhadrinath in North Hindustan; of Tooee, near Ruttenpore on the Mhye river, in Guzerat; of Lawsoondra, eighteen miles W.N.W. from Tooee; of Uteer, about thirty miles from Poorea near Korachi, on the Indus; of the diamond district at Punnah, in Bundelcund; of Oetha-gur, and Bannassa, near the sources of the Jumna; of the rivulet of Loland Khad near the Sutledge; of those near the confluence of the Soar and Elgie rivers with the Ganges; of many known to exist in the Birman empire and Malayan peninsula, and of Bhotan. The last-mentioned springs throw up spheroids of silex, which are brought to Almorah and there sold by the native merchants for duck shot*. These spheroids resemble those of the springs of Carlsbad in Bohemia, and of the Geysers. The silex composing them has doubtless been held in solution by the water; but it remains yet to be shown whether it contains, or not, that peculiar combination of silica and soda, which, according to Mr. FARADAY, characterizes the water of the Geysers†; a combination ceasing to exist when the water is evaporated: the silica being then de-

* M'LELLAND.

† BARROW's Visit to Iceland, pp. 209, 211.

posited in an insoluble condition, while the alkali, probably by the agency of the carbonic acid of the atmosphere, is set free, and remains dissolved in the water in considerable quantity. In Southern India many thermal springs, hitherto entirely unnoticed, are suspected to occur; Colonel SYKES states that he has been informed of their existence in Canara: I have heard of one among the Raidrúg hills in the Ceded districts,—in the Koondahs on the west coast,—and discovered another at the base of the hills south of Cuddapah having a temperature of 88°, as noted in the register. A spring near Salem in South India is probably thermal, having a temperature of 84°, ascertained for me by Mr. G. FISCHER.

Temperature of Rivers.—The supposition that the temperature of rivers is lower, from the influence of evaporation, radiation, and the elevation at which they rise, than that of the country through which they flow, appears subject to some modification as regards great streams whose course lies chiefly through equinoctial regions. Many, like the Nile, derive the great bulk of their water from the rains that fall periodically near the equator when the sun is nearly vertical, and evaporation reduced to its minimum from the saturated state of the atmosphere. The fallen waters derive additional heat in overspreading the wide extent of sand and alluvium that form and skirt the channels through which they roll on towards the ocean; and which, during great part of the year, have been left dry and freely exposed to the rays of a scorching sun. The beds of the most considerable rivers of South India present in many parts of their course, during the dry season, dreary wastes of arid sands, through which the river, reduced to a slender thread, barely finds its way to the sea. The mean of more than 200 observations, taken day and night, on the temperature of the Nile, in July, between Cairo and Thebes, I found to exceed the mean annual temperature of the air at Cairo (72°·4) by 7°·1. The temperature of the river was increased, at the commencement of the inundation in June, by the freshes from Abyssinia from 79° to 80°·5. The observations were taken at Thebes, immediately preceding, and immediately after, the appearance of the turbid milky hue that announces the periodical arrival of Egypt's great benefactor.

The Ganges, though having its source amid the snows of the Himálaya, and pursuing an opposite course to the Nile, that is, a course from northerly latitudes towards the equator, has a mean temperature, as it approaches the ocean, higher than that of the country on its banks. Its mean, between Calcutta and the sea, obtained from a great number of observations by Mr. G. PRINSEP, is stated not to be less than 81° FAHR.! while that of Calcutta does not exceed 78°. The Ganges, it is well known, is little indebted to the melting of the snows near its sources, but derives its waters chiefly from the periodical rains that fall near the borders of, and within, the tropics, between 30° and 22° N. lat. During the inundation, its waters in the lower parts of Bengal are spread over a superficies of alluvial soil and sand, more than 100 miles in breadth, the greater part of which has been parched by the droughts prevalent between the monsoons.

In order to obtain a better idea of the degree of heat absorbed and given out by the alluvium of the Nile, the sands and rocks in the beds of the rivers of India, I made the following observations.

In July 1840, a thermometer placed on the dark alluvium, then quite dry, of the Nile opposite the pyramid of Meydún at 12½ P.M., having its bulb covered 0·1 of an inch with the same alluvium, stood at 136°·5. With, and on, the sand of the desert on the verge of the inundation line, at the same hour, it stood at 121°·5. The temperature of the air at the time, five feet above the surface of the dark alluvium, was 105°·5: the same height above that of the desert, it was 103°·5; sky unclouded. Although the surface of the sands during the clear serene nights of Egypt is cooled considerably by radiation, still a little below the surface they retain a great portion of the solar heat. In July, at sunrise, the surface of the sandy desert, on the banks of the Nile at Thebes, lat. 25° 26′ N., which during the heat of the day indicated a temperature of 130°, had cooled down to 69°·5, while the thermometer a foot *below* the surface stood at 83°: temperature of the air 75°.

The temperature of the granite rocks in the beds of the Toombuddra and the Kistnah, during the months of May and June, at 2 P.M., I found from 118° to 120°: during the night they cooled down usually to 83°. The temperature of the surface sands in these rivers was slightly higher than that of the granite.

The temperature of rivers whose supply, like those in South India, depends more on the periodical rains than on springs, is consequently influenced by the temperature of the former. That of the monsoon showers, which fell on the western coast near Mangalore during the months of May and June, varied from 73° to 79°, affording a mean of 76°. The rains falling on the elevated table-land of the Ceded districts, from June to December, ranged from 71°·5 to 79°·5, giving the mean 75°·5. The mean general height of the plain, between lat. 13° and 17° N., is 1300 feet above the sea's level. The temperature of the showers was invariably modified by the conditions affecting that of rain water in extra-tropical countries, namely, the elevation at which condensed, and the temperature of the atmospheric strata through which the showers fell.

The temperature of the Brahmapútra river at Sadya in Assam, was found in September by Mr. GRIFFITHS to range from 63° to 70°. That of the air above the river, from 68° to 100°. That of the Indus, by GERARD, in March, near Attock, was 32°.

Temperature of the Ocean on the Equator and between the Tropics.—The influence of the trade-winds, cold currents from high latitudes, frequent showers, evaporation, &c., contribute to cool the air and surface of the ocean at the equator. The extremes of the temperature of the latter, at great distances from land, have been pretty correctly stated by M. ARAGO at 80°·8 and 84°·2. On crossing the line in the Atlantic Ocean (in long. 20°·7 W.) I found the temperature of the sea 84°·5; air in the shade, 87°: in the Indian Ocean (long. 58°·54 E.) 81°·5; air in the shade 82°·5. In the

same oceans, near the land, and in narrow seas, the range between the extremes is much greater than 3°·4. In the Red Sea, from the Straits of Babelmandel to the tropic of Cancer, I found it, in the month of May, to be 6°, viz. from 82° to 88°; and in the Indian Ocean, from lat. 12° to 19°, so much as 8°·5, viz. from 78° to 87°·5. In the Straits of Malacca, in lat. 2° N., it ranged from 80° to 85°·2.

On some parts of the west coast of India (where 123½ inches of rain falls during the year), during the monsoon, the surface of the sea is considerably cooled by the freshes from the numerous rivers and streamlets that descend from the lofty mountains of the Ghauts. Off Honáwer, lat. 14° 16′ N., the temperature of the sea during the dry season was 85°·5. During the monsoon it fell to 79°; average temperature of rain water at the time, 75°·7; of rivers, 76°. From its inferior specific gravity, the fresh muddy water from the hills floats on the surface of the sea to considerable distances, without being intimately blended. In the depth of the monsoon, near Mangalore, in 1839, the water was observed to be nearly fresh a mile off the coast; and I have seen the Mediterranean discoloured by the turbid inundation of the Nile to a distance of nearly forty miles from the Damietta embouchure.

Mean Temperature in India.—Colonel Sykes, in his statistics of the Deccan, has already noted one remarkable feature touching the mean temperature of places at elevations on the table-land of India, namely, that it is much higher than the mean for the same places, calculated agreeably to Mayer's formula. To the instances he has cited of this fact, of places on the plateau of the Deccan, may be added the following, occurring on the table-land of South India.

Places.	Feet above sea.	Lat. N.	Observed mean.	Calculated mean.	Difference.
Hydrabad ..	1720	17° 15′	80°	74°·72	5°·28
Nagpore	1101	21 10	80	74·26	5·74
Bellary......	1600	15 5	80·5	76·12	4·38
Bangalore ..	3000	12 57	74·39	73·05	1·34
Seringapatam	2412	12 25	77·06	74·93	2·13

Among the principal causes of this differential height of temperature,—a difference more remarkable when compared with the indications afforded by the improved formulæ of Brewster, D'Aubuisson and Atkinson,—may be enumerated the physical aspect and extent of the elevated plains on which these places stand,—the rapidity with which the drainage water passes off, and consequent little evaporation,—the comparatively flat, or gently undulating surface,—its bareness of vegetation during great part of the year,—the non-influence of alternations of land and sea breezes, by which places near the sea are cooled,—the partial influence of the monsoon and scantiness of rain,—the favourable conditions of the atmosphere for irradiation, and the capacity of the soil for imbibing and giving out the solar heat. The temperature of the granitic soil in the vicinity of Bellary, at 2 p.m., in May, reached 121°; that of the Régur, or black soil, 122°·5: the temperature of the air in the shade, 95°·5: at midnight the temperature of the black soil was still so high as 86°; temperature of the

air 80°. That of a bare rock of granite, the same locality, at 2 P.M., was 120°·5; of black basaltic rock 122°. The temperature of the granite at midnight was 86°·5. Both Bellary and Hydrabad are situated under the shade almost of bare granitic masses, in the midst of plains covered with sheets of the granitic and black régur soils just alluded to, whose almost treeless extent during the hot months is shrunk up and intersected by deep and countless fissures. The climate of the former station is nearly as dry as that of Egypt. In 1838 only 11·25 inches of rain fell during the year. The atmosphere is remarkable for transparency and freedom from clouds. The foregoing views appear to be strengthened by the fact, that the observed mean temperature of the elevated stations of Ootacamund (7221 feet above the sea's level), Mercára (4500 feet), and Candy in Ceylon (1680 feet), are *lower* than their calculated mean temperatures. The calculated mean of Ootacamund is 61°·64, observed mean 55°·8; of Mercára 68°·99, observed mean 65°·58; and of Candy 78°·58, observed mean 73°·3. Now all these places are surrounded by an irregular surface of hill and valley, generally clothed with eternal forest, presenting an extensive radiating and evaporating surface, and shading the drainage of heavy monsoons that lingers in their swampy hollows. The humidity of the atmosphere at these stations is very great; at Mercára, during nearly half the year, its hygrometric condition closely approaches saturation. Hence, favoured by the alternations of land and sea breezes, even close to the sea's level, the low temperatures of some places near the equator, viz. Singapore, lat. 1° 15′ N., mean temperature 80°·7; Malacca, lat. 2° 14′ N., mean temperature 80°·4; Penang, lat. 5° N., mean temperature 80°·5; Province Wellesley, lat. 5° 20′ N., mean temperature 79°·5. The monsoons are distributed over these forest-clad regions of the equator in an almost daily succession of refreshing showers throughout the year. May not the vital functions of the plants, covering large tracts of country, particularly those concerned in their respiration and nutrition, exert an influence in cooling over-heated states of the atmosphere?

It may be further stated, in corroboration of the high temperature of table-lands being mainly produced by the causes referred to above, that the temperature of isolated peaks and summits of ridges, rising with a rapid ascent and confined superficies from their elevated level, appears to diminish in a greater ratio than 1° FAHR. for every 352 feet of ascent; when, perhaps, that of the aggregate height from the sea's level is in strict accordance with this rule. The mean of a month's observations by Lieut. CAMPBELL, at the summit and base of the rock of Raya-Cottah on the table-land of Mysore, above which it is elevated 500 feet, gave a decrease of temperature amounting to 3°·35. The diurnal mean difference between the temperature of the summit of a mountain on the table-land of Bellary, and that of the plain at its base, I found so great as 7°·5 for the 1500 feet of elevation which separates them. This table-land has a mean temperature of nearly 4°·5 above its calculated mean. The difference of temperature of two wells, one at the summit of Mount Sinai, and the other 2000 feet below, amounted to 6°, a result closely approximating that of the comparative observations at Geneva and St. Bernard.

The highest known mean temperature of any place in India is that of Pondicherry, which, though this city stands only a little more than a degree to the south of Madras, is stated to reach 85°·28. That of Madras, in lat. 13° 5′ N., is 80°·42, and of Columbo, more than 5° nearer the equator than Pondicherry, only 80°·75. I am not aware that any reason has been assigned for this extraordinarily high mean temperature; the lower temperature of some wells in the vicinity of Pondicherry leads me to doubt its correctness.

Boussingault's *Mode of ascertaining the Mean Temperature of Tropical Countries.*—An expeditious mode for ascertaining the approximate mean temperature of equinoctial regions has been proposed by M. Boussingault, and recommended to travellers, on occasions where time and opportunity do not admit of the usual means. I hardly need remark, that this method is grounded on the hypothesis, that between the tropics the temperature of the earth's crust is constant at the depth of about a foot (one-third of a metre) beneath its surface, and consists in sinking a thermometer in the soil perforated to this depth, under sheds, huts of natives, or other spots sheltered from direct warmth produced by absorption of the solar heat, from nocturnal radiation, and from the infiltration of rain water. The result of my own experiments in India indicates that the soil at the depth of a foot is subject to an annual, and, in light soils, to a diurnal fluctuation, varying according to the intensity of the sun's rays on the soil surrounding the sheltered spots where the experiments were conducted; and radiation modified by the dry and open, moist and close nature of the soil. During cloudy weather these fluctuations were consequently found at their minimum. The maximum of diurnal fluctuation observed was at Bellary, on the centre of the table-land of peninsular India, in lat. 15° 5′ N., and 1600 feet above the sea's level; mean temperature about 80°·5. The experiments were made in the hot month of May, sky unclouded; the soil was reddish and light in texture, and completely sheltered by a thatched roof. Every precaution enjoined by M. Boussingault was carefully attended to, and fresh holes bored every day.

Experiment.—*First Day.*

	Earth.	Air in Shade.
Sunrise . . .	86°·5	81°
2 P.M.	91·3	96·5
Second Day.		
Sunrise . . .	85	78
2 P.M.	89	92
Third Day.		
Sunrise . . .	85·5	78·5
2 P.M.	90	95
Fourth Day.		
Sunrise . . .	87	75
2 P.M.	89	92

At Cassergode, on the west coast, lat. N. 12° 29′, whose mean temperature is about 80°, the diurnal fluctuation amounted to only 1°·5 in cloudy weather. At Mangalore, on the same coast, lat. N. 12° 53′, it amounted on a clear day to 2°·75. The last experiment was made, at my request, by my friend Mr. B. G. Maurice, Madras Medical Service. In stiff clayey soils, at the depth of four feet from the surface, and sheltered to the distance of six yards radius from the spot perforated, the temperature fluctuated but little, and gave a tolerably correct mean of the air. In light sandy soils a greater depth is necessary; and at all times it is advisable to observe the temperature of the perforation in the soil at the coldest and hottest periods of the day, which, with an unclouded sky, will be found to occur at, or just before, sunrise, and from 2 to 3 P.M. Such observations should, if possible, be compared with the temperature of a spring or well of moderate depth, at from six to ten feet below the surface, bearing in mind what has already been stated regarding the causes affecting the temperature of wells and springs.

Temperature of Springs and Wells.

Names of Places.	Position in Lat. N.	Position in Long. E.	Approximate height in feet above the sea.	Formation in which situate.	Depth to surface of water.	Depth of water.	Temperature of air in shade at time of observation.	Temperature of water.	Approximate annual mean temperature of air.	Months of observation.	Remarks.
	° ′	° ′			ft.	ft.	° ′	° ′	° ′		
Alexandria	31 13	27 35	Shore.	Limestone.	20	6	79 5	74 5	....	July.	Large ancient reservoirs underneath the old city, communicating with the surface by narrow shafts, fed by Nile at high water.
Cairo	30 2	28 58	50	Limestone.	21	8	80 0	76 0	72 4	July.	Water brackish; shaft three feet in diameter.
Thebes	25° and 26°	30° and 31°	....	Limestone.	10	5	82 0	79 0	....	June.	Water brackish; shaft three feet in diameter.
Mount Sinai (summit)	28 33	34 0	7000	Granite.	16	9	75 0	55 0	....	June.	Rain-water collected in deep cavity on summit. RUPPELL makes summit 7035 French feet. MORESLEY 5956 English feet. Mean of two observations by WELLSTED, 7505; 2500 above Convent. Three last are springs from three to four feet in diameter.
Fount of Elias (ascent of Mount Sinai)	....	....	6000	Granite.	14	7	73 4	58 5	....	June.	
Spring of Mariam (ascent)	....	....	5500	Granite.	1	2	79 2	59 5	....	June.	
Well at foot of Mount Sinai	....	....	5000	Granite.	4	20	79 0	61 0	....	June.	Narrow shaft, about four feet in diameter.
Wells of Tor	28 15	33 38	80	Limestone.	4	1½	84 0	77 2	....	June.	About four feet in diameter; possibly thermal.
Wells of Ambajeh (Egyptian Desert)	26° and 27°	31° and 32°	200	Limestone.	1	½	84 0	82 5	....	June.	Spring on surface. Saline, muriate and sulphate of soda.
Wells of Hammamet (Egyptian Desert)	26 10	31 0	700	Sand and sandstone	130	½	85 0	76 2	....	June.	Brackish. Shaft two or three yards in diameter.
Bombay	....	....	Shore.	Trap.	10	5	82 0	79 5	....	April.	Narrow shaft, four feet in diameter.
Beder	17 49	77 46	2300	Laterite.	200	6	82 0	79 0	77 5	June.	Narrow shaft, four feet in diameter.
Calliany	17 50	77 5	....	Laterite.	35	10	89 0	78 5	....	July.	Narrow shaft, four feet in diameter.
Hydrabad	17 15	78 35	1720	Granite.	4	10	87 5	79 5	81 0	June.	Large open spring of pure water, ten or twelve yards in diameter.
Hydrabad	17 15	78 35	1720	Granite.	20	12	87 0	80 0	81 0	June.	Deep wells of pure water, narrow shaft.
Wells between the Kistnah and Hydrabad	15° to 17° 50′	....	900 to 1720	Granite.	6 to 30	6 to 10	84° to 87°	78° to 80°	79 81	June.	Wells of pure or slightly brackish water.
Gokauk	16 11	74 58	....	Sandstone.	10	4	78 5	75 5	....	July.	Shaft four feet in diameter.
Darwar	15 20	75 8	2400	Clay-slate.	12	8	79 3	75 3	75 0	July.	Shaft four feet in diameter.
Ceded districts	....	....	500 and 1600	Sandstone. Limestone. Granite.	....	....	....	....	78 5	July.	This is the average temperature of twenty-one springs and bouries between lat. 13° and 17° N., taken at all seasons of the year.
Udigherry	14 52	79 22	....	Sandstone.	10	5	82 0	78 5	....	January.	Shaft five feet.
Bunwassy	14 32	75 8	....	Laterite.	2	1	72 5	75 8	....	July.	Open bourie.
Nellore	14 28	80 3	100	Laterite.	5	2	82 0	78 5	....	January.	Shaft five feet.
Kistnapatam	14 25	80 9	Shore.	Laterite.	10	4	82 2	80 0	....	January.	Shaft five feet.
Honawer	14 16	79 56	Shore.	Laterite.	4	6	78 0	79 0	78 5	July.	Open well, about four yards square.
Madras	13 5	80 22	Shore.	Granite.	6	12	80 8	80 6	80 42	February.	Shaft five feet in diameter.
Mangalore	12 52	74 52	Shore.	Laterite.	3	20	80 0	80 75 and 81 0	80 21	June.	Shaft six feet in diameter.
Beypoor	11 11	75 53	Shore.	Laterite.	20	6	83 4	81 3	80 5	March.	Shaft four feet in diameter.
Malacca	2 14	102 0	Shore.	Laterite.	40	8	84 0	80 5	80 4	June.	Spring, about three feet square.

Temperature of Rivers.

Names of Places.	Position in: Lat. N.	Position in: Long. E.	Position in: Approximate height in feet above the sea.	Formation in which situate.	Depth to surface of water.	Depth of water.	Temperature of air in shade at time of observation.	Temperature of water.	Approximate annual mean temperature of air.	Months of observation.	Remarks.
	° ′	° ′	ft.			ft.	° ′	° ′	° ′		
Cauvery	12 20	76 47	2412	Gneiss.	....	12	85 0	77 5	77 06	May.	
Pennaur	14 28	80 3	100	Laterite.	....	6	82 4	79 5	....	January.	
Gaorsippa river	14 16	75 45	....	Gneiss.	....	15	72 5	75 5	....	July.	
Gaorsippa at sea	14 16	75 25	Shore.	Laterite.	....	10	78 0	78 5	....	July.	
Rivulets of Western Coast	13° and 14°	75 0	Shore.	Laterite.	....	....	77 5	78 0	....	July.	
Tambuddra	15 44	78 2	880	Limestone.	....	12	85 0	79 0	....	May.	Swollen and muddy by monsoon; January coldest month, its temperature was 69° 5′.
Hendri	15 44	78 2	880	Limestone.	....	10	83 0	78 5	....	June.	Swollen and muddy by monsoon; January coldest month, its temperature was 69° 5′.
Kistnah	15 57	78 2	910	Limestone.	....	15	89 0	79 0	....	June.	Swollen and muddy by monsoon; January coldest month, its temperature was 69° 5′.
Gokauk	16 11	74 56	2800	Sandstone.	....	12	82 0	75 6	....	July.	
Birna	17 7	....	1730	Limestone.	....	....	....	78 0	....	June.	
Godavery	18 0	....	130	Granite.	....	14	79 0	74 5	....	June.	
Indus, near Attock	....	....	....	....	....	....	....	32 0	....	March.	GERARD.
Brahmapútra, in Upper Assam	....	....	....	....	....	....	68° and 100°	63° and 70°	....	Sept.	GRIFFITHS.
Ganges	21° and 23°	....	....	Alluvium.	....	....	....	81 0	78 0	Annual mean.	G. PRINSEP.
Nile	25 and 30	....	....	Limestone.	....	....	81 0	79 5	....	June & July.	

Temperature of Thermal Springs.

Names of Places.	Position in: Lat. N.	Long. E.	Approximate height in feet above the sea.	Soil on rock in which situate.	Depth to surface of water.	Depth of water.	Temperature of air in shade at time of observation.	Temperature of water. FAHR.	Approximate mean annual temperature of air.	Months of observation.	Remarks.
			ft.		ft.	ft.	°	° ′			
Jauri on Sutledge	30° and 32°							130 0			HAMILTON. Sulphurous.
Jumnotri	30° 52′		10,849	Granite.				194 0			HODGSON. Ferruginous.
Muktinath	29 9	83° 18′									
Bowitti (Oasis parva, Egypt)	28° and 29°	27° and 28°	300	Sandstone.				92 75			WILKINSON.
El Kasr (Oasis parva, Egypt)	28 and 29	27 and 28	300	Sandstone.				93 5			WILKINSON.
Sonah, near Delhi	28 and 29	76 and 77		Sandstone.				108 0			LUDLOW.
Hummám Músa (Wells of Elim?) near Tor	28° 5′	33° 38′	60	Limestone.	2	2½	89	91 6		June.	
El Kasr in Oasis of El Dakhleh	26° and 27°	27° and 28°	250	Limestone.				102 0			WILKINSON.
Sitakhund	25 and 26	86 and 87		Quartz.				140 0			ADAM. Tasteless, clear, gaseous; gas not ascertained.
Bheembund	24 and 25	86 and 87						144 0		March.	BUCHANAN.
Rajaghiri	24 and 25	85 and 86					70	108 0		October.	FULLARTON, and As. Journal, vol. iii. Saline.
Hazarybaugh	24 and 25	85 and 86						108 0			H. WILSON and FULLARTON. Sulph., hyd., mur., and sulph. of soda.
Hazarybaugh	24 and 25	85 and 86						170 0			
Hazarybaugh	24 and 25	85 and 86						190 0			
Kutkunsandy	23 and 25	86 and 87		Trap and Granite.		1	41	114 0			FULLARTON.
Tantotya, near Pachete Hills	23 and 24	86 and 87						190 0			BELL. Slightly chalybeate.
Kyrie	22 and 23	78 and 79		Trap.			86	114 0		February.	SPILSBURY. Sulphurous, nearly pure water.
Maljihir	22 and 23	78 and 79		Trap.			92	134 0		February.	SPILSBURY. Sulphurous, nearly pure water.
Devaki, Unei	20 and 21	73 and 74		Trap (?).				111° & 120°			Dr. WHITE.
Kais	19° 59′	78° 58′		Trap and Limestone.			81° to 100°	87 0		June.	MALCOLMSON. Carbonic lime and carbonic acid gas.
Baugha	18 12	81 0	200	Sandstone and Limestone.				110 0			VOYSEY.
Gondála	18 0	81 17	130	Granite and Trap.			70	120° & 139°			VOYSEY.
Allayen (Moulmein)	16° and 17°	98 0		Limestone.				137 0		December.	FOLEY.
Bhuga, near Cuddapul	14 and 15	78° and 79°	560	Sandstone.	2	2½	65° and 90°	88 0	79° 5′	December.	
Spring, near Salem	11° 37′	78° 13′	2000	Gneiss and Hornblende slate.	2	3		84 0		March.	FISCHER.
Cannia (Ceylon), seven springs	8° and 9°	81° and 82°		Quartz.			77	86° & 107°			DAVY.
Sabung, Malacca	2 and 3	102 and 103	500	Granite.	Surface	3	105° in sun.	130 0	80 5	July.	
Ayer Pannas, Malacca	2° and 3°	102° and 103°	400	Granite.	Surface	2½	89°	113° 5′ and 120°	80 5	March.	

Comparative Register of the Temperature of the Air (in the shade) and of the Sea, from Bombay to Suez. The indications of thermometer are adjusted to those given by the standard of the Royal Society.

Month.	Lat. N.	Long. E.	Noon. Air.	Noon. Water.	Midnight. Air.	Midnight. Water.		Remarks.
May 1.	18° 36′	71° 41′	No obs.°		No obs.°		Indian and Arabian Seas.	
2.	18 5	69 38	87·5	85·5	86·5	84·5		
3.	17 30	67 28	87	86·5	87	No obs.		
4.	16 57	69 12	86	84	86·5	No obs.		
5.	15 29	63 5	87·5	85·5	85	85		
6.	15 52	60 53	87	85·5	85	84·5		
7.	15 19	58 40	85	83	86	84·5		
8.	14 56	56 17	85·5	82·5	85·5	82·5		
9.	14 27	53 56	85·5	84·5	83·5	84		
10.	13 43	51 39	86·5	83·5	84·5	84·5		
11.	13 32	48 43	88	85·2	87	85		
12.	12 46	45 53	89	86·6	87	85·5		Off coast of Arabia.
13.	Aden.	Aden.	89·5	87·8	86·5	86		Back Bay, at anchor.
14.	12 49	43 21	88·7	86	85·5	84·5	Red Sea.	
15.	15 14	41 55	88	86	84	84		In sounding, off volcano of Gevel Teer.
16.	17 28	40 20	87·5	87	87	84·5		Sun's rays 115° 2 P.M.
17.	19 55	38 52	90	88	85	85·5		Sun's rays 120°·5 2 P.M.
18.	22 23	37 21	86	84·5	85·5	82		
19.	24 38	36 13	84·2	80·5	82	79		
20.	26 38	34 45	84	80·5	89·5	82		Suez, hot khamsin set in about 10 P.M.

Memoranda supplied by the kindness of a friend from the register kept on board the Honourable East India Company's Steamer Cleopatra, from Bombay to Suez.

Month.	Lat. N.	Long. E.	A.M. Air.	A.M. Water.	P.M. Air.	P.M. Water.	Remarks.
April 2.			89°	84°	81°	78°	
3.			84	83	80	78	
4.			84	84	81	83	
5.			81	83	81	83	
6.			80	82	80	82	
7.			No entry.		No entry.		
8.			No entry.		No entry.		
9.			No entry.		No entry.		
10.			No entry.		No entry.		At Aden.
11.			No entry.		No entry.		Passed Straits of Babelmandel.
12.			86	84	86 5	84	
13.			87	84	81	82	
14.			79	82	79	80	
15.			No entry.		No entry.		
16.			84	76	73	71	
17.			75	82	No entry.		Passed Island of Shadwan.
18.			No entry.		No entry.		Suez Bay.

N.B. The latitude and longitude have been omitted in the above register; but after making allowance for the more rapid run of the Cleopatra than that of the vessel in which I left India, and calculating from Bombay to the Straits of Babelmandel, and thence to Suez, an approximation may be made to the vessel's situation at the time of taking the observations. The indications could not be adjusted to the standard thermometer of the Society.

Note on the Thermal Springs of the Peninsula of India.

Since my arrival here my friend Mr. MALCOLMSON has put into my hands the first volume of the Bombay Medical and Physical Transactions, where I find, p. 257, a few notes on the thermal springs in the Konkan, by A. DUNCAN, Esq. The geographical distribution of these springs corroborates the remark in my paper under the head of thermal springs, viz. " that the majority of the springs termed thermal occur in India at or near lines of great faults." The thermal springs mentioned by Mr. DUNCAN lie at the base of the Western Ghaut elevation, intermediate between the mountains and the sea, generally from sixteen to twenty-four miles, or thereabout, inland from the latter. The line of springs follows pretty nearly that of the mountains, viz. nearly north and south, and extends from the vicinity of Surât, or about 21° N. lat. to South Rajapore: they are supposed to exist still further south, following at irregular intervals the line of West Ghauts to Ceylon. Not less than twelve are known to exist between Dasgaun and South Rajapore, viz.—

1 at Oonale in the taluk of Viziadroog.
3 in the Rutnaghirry taluk, at Rajwaree, Tooril and Sungmairy.
1 at Arowlee in the Konedree taluk.
1 at Mat, Hatkumbee Mahal.
1 at Oonale, in the Natoe Palivan Mahal, Severndroog.
3 at Oonale, Jaffrabad Mahal.
1 at Savi, in the Ryghur taluk, Bhar Nergannah.
1 at Oonale, Sankse taluk, Mahal Palee.
—
12 total.

Oonale is the native term for a hot spring. The temperature of all the springs examined exceeded, with a single exception, 100° FAHR., and amounted to 109°. That of Tooril, which unfortunately was not thermometrically ascertained, appeared to Mr. DUNCAN to be almost at the boiling-point. The water was not found to be mineral, though impregnated with sulphuretted hydrogen. A little higher up, on the hill where the thermal spring No. 1 occurs, is a singular intermittent cold spring, over which a temple has been built. It is resorted to by crowds of Hindus during the season when the fountain periodically flows, viz. during the hot months. A more minute analysis of the water, and a more continued series of thermometric observations, are a great desideratum.

The temperature of a hot spring of Oonye in the jungle between Bansda and Boharee is asserted by the Brahmins to diminish annually at the time of the full moon in April, so as to admit of persons bathing in it at this period, when the natives assemble there in great numbers for that purpose. This assertion was contradicted by the late Dr. WHITE, but the question, I see, has again been raised by the observations of Mr. J. S. LAW, of the Civil Service, who found the temperature of the hottest part of the spring to have diminished at this period from 124° to 94° FAHR. It is probable however that future observations on this supposed singular annual variation will set the matter at rest.

Bombay, July 15, 1842.